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## EMBRYOLOGY.[1]

**Epigenesis or Evolution?**[2]—One part of this paper is devoted to the results of certain experiments upon the action of light upon the cleavage of eggs. These show that the eggs of *Echinus microtuberculatus, Planorbis carinatus?* and *Rana esculenta* undergo cleavage and the early stages of organ formation equally well in darkness, white light or colored light. Light then has no effect upon the early stages of development, though others have shown that the presence or absence as well as the color of light does have an effect upon the later stages of differentiation of embryos.

The main portion of the paper, however, contains the most interesting results: that from one of the first two blastomeres of the egg of *Echinus microtuberculatus,* and the same is true of a species of *Sphærechinus,* a complete pluteus of normal form but of half the normal size may be reared!

Owing to the importance of these experiments as bearing upon the value of the blastomeres upon the question of early potential reparation of organs within the egg, that is, upon the question of evolution as opposed to epigenesis, it will be necessary to give here a brief account of the author's methods, from which the chance of error may be deduced.

When the first cleavage furrow has come in, 50–100 eggs are shaken vigorously for five minutes, with little water in a test tube 4 cm. long and 0·6 cm. wide, then quickly poured into clean sea water and examined. If the right moment has been taken, neither too soon nor too late, some of the blastomeres will be found not only isolated but still alive, others of course dead, or not separated from their fellows as the egg membrane does not always burst open. There is also great variations in the resistance offered by eggs of different individuals—some may need to be shaken several times.

The best isolated cells are removed and placed two or three together in sea water in solid watch glasses covered, and with a hanging drop on the cover to diminish evaporation and concentration of the sea water. In these glasses the embryos develop and were observed from time to time without removal.

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[1] Edited by Dr. T. H. Morgan, Bryn Mawr College, Bryn Mawr Penn.

[2] Hans Driesch: Entwick lungs mechanische Studien. Zeit. f. wis. Zool. liii, Nov., 1891.

The normal cleavage as shown by Selenka is accomplished as follows: two meridional furrows followed by an equatorial make eight equal cells, four of which bud out four little cells at one pole while the other four divide. There is thus a stage with 16 cells, marked by 4 small ones at one pole: these remain evident during the 28, 32, 60, 108 cell stages.

Now in the great majority of artificially isolated single blastospheres the cleavage results in the formation of a half blastula. The single cell divides into 2 and then in 4 equal cells: then the two upper cells bud off two small cells while the two lower cells divide, forming then 8 cells arranged just like one-half of the normal 16 cell stage. The time taken for the half-egg to reach the 8 cell stage is the same as for the whole egg to reach the 16 cell stage.

Though in the majority of cases the evening of the first day saw half blastulas formed from the half-eggs, there were also present certain cases in which from the first or from later stages of cleavage the half-egg formed a symmetrical though small sphere, not a half sphere.

The next morning revealed actively swimming complete blastulæ formed from the half blastulæ, though of small size, yet normal. How the half sphere closed in was not observed. As they are only one-half the normal size yet have cells of the normal size the number of cells must be one-half the normal. Whatever the mode of closure of the half-sphere may be, its occurence shows that the half-egg is able to furnish a complete individual, both right and left, anterior and posterior, dorsal and ventral parts, and had not given up part of this power to the other egg-half.

Of the 30 perfect blastulas only 15 survived the second day—as is often the case with normally formed blastulas in small vessels. On the morning of the third day active gastrulas were observed, fifteen individuals. They then take on the prismatic form, mouth and arms are formed and the normal course is followed until finally, in 3 cases, normal, but small, plutei were raised.

If each half-egg may thus form a complete individual the possibility of forming twins by partial separation of the first two blastomeres is obvious. In fact very many cases of twin formation resulted from the experiments above recorded though in eggs not shaken none were observed amongst the many examined in other work. There is thus probability that the partial separation of blastomeres may give rise to twins. Of the numerous cases of twins actually observed one is especially noticeable as it shows that from a much injured two celled stage there resulted an apparently normal blastula which after two days divided into two almost separated spheres each of which became a gastrula and finally a pluteus attached by a narrow isthmus to its fellow.

This abnormal action of the embryo is not confined to a simple two-fold division: in three cases the blastula divided into a $\frac{3}{4}$ and a $\frac{1}{4}$ section of which the former became plutei and the latter, in one case a gastrula. The general distribution of this power to produce complete individuals was more striking in a case where $\frac{3}{4}$ of a shaken egg, in the two celled stage, died and the remaining $\frac{1}{4}$ of the egg became a normal blastula!

Attempts made by the author to separate the blastomeres of Frogs and of Planorbis have as yet been unsuccessful. There seems need of extension of this experimental work before any wide-reaching conclusions can be drawn.

**Regeneration of Lost Parts.**[1]—In these two papers the author has given an important addition to our knowledge of the process of regeneration of the tail in Batrachia. Both adult and larval urodeles and larval anurans were used, though most of the work refers to Rana and to Siredon larvæ. In the first paper the interesting fact is established that tails cut off obliquely do not grow out straight at first, but at right angles to the cut surface, up or down, right or left as the case may be. Yet they become later like the original tails. This change the author assigns to the effect of use, to functional adaptation. This is made probable by a number of experiments in which larvæ were kept in deep and in shallow water, could or could not use the tail. Some of the final straightening in the non-swimmers is referred to the effect of gravitation, but there still remain cases in which only the " directive power " of the organism seems to be concerned in the ultimate return of the new tail to its proper use.

The great length of the second paper forbids its proper treatment in the present notice. Its chief advance over previous work, of which it furnishes a good confirmation, lies in the discovery of the fact that the histological changes concerned in the formation of the new tail repeat, on the whole, those of the ontogeny, not only in kind but in the time of appearance. Thus the epidermis is first regenerated, then the spinal cord, chorda, connective tissue, cutis, blood-vessels, striated muscles and peripheral nerves in the order given. Simple tissues are quickly regenerated, the more specialized, more slowly. Moreover, the mode of formation of tissues like that in the embryo is dependent upon the ontogenetic stage of the individual, repeating only what is proper to the formation of such tissues at that stage.

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[1] D. Barfurth. (1) Versuch zur functionellen Anpassung. (2) Zur Regeneration der gewebe Arch. f. mik. Anat. xxxvii, May, 1891.

**Embryology of Rotifers.**[1]—Passing over the anatomical and biological sections of the present long paper, interesting as are the new facts brought forward to support the author's belief in a symbiosis between certain rotifers and certain hepatic mosses, and the careful anatomical work upon the Callidinas studied, we will here give a brief outline of the embryological and theoretical sections.

The eggs of *Callidina rosseola* and *C. lutea* may be found by shaking out moistened roof-moss and examining the dust with a lens, or better, by placing a number of the ripe females in small glasses where the eggs are less liable to be rendered opaque by the adherence of foreign bodies to their sticky surface.

As the egg is large, elongated and requires 17 days to develop, it furnishes an unusually good chance to study the cleavage at leisure, there being moreover resting periods of long duration. From the author's account of the continued rearrangement and shifting of blastomeres within the egg membrane these eggs would seem also to be favorable objects for investigating the relationship of cleavage planes and cell arrangements to mechanical pressure and spacial necessities.

The polar body is exceedingly large (only in some cases were two present) and is formed on what proves to be the dorsal surface near the anterior pole, so from this early stage all the planes of the adult are oriented by this appearance at the end of one side of the elongated egg.

Of the first two cells the larger, I, takes the anterior pole, the smaller, A, posterior; both divide. The first progeny of I form a series of cells on the right side, the progeny of A are arranged on the dorsal and left side. Other cells are budded off from I and form a ventral series. Thus an elongated, solid mass of four rows of cells arise, having the large remnant of I at its anterior end, 16 cells in all.

An increase in the number of cells is accompanied by their moving forward over the remnant of I which now sinks into the interior and furnishes the cells of the entoderm: this being a solid gastrula stage. A few smaller, granular cells, likewise overgrown at the same end of the egg come to lie beneath the ectoderm and are regarded as furnishing the material for the pharynx and salivary gland.

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[1] Carl Zelinka: Studien über Räderthiere Zeit. f. wis. Zool. liii, Nov. 1891.

Of the subsequent fate of the embryo to the time of its hatching in the adult form we can only note from the detailed organogeny given by the author the facts that the reproductive organs arise from two small sets of cells given off from the progeny of I, that is from the entoderm: that the nervous system and muscles both come direct from the ectoderm, the former as solid ingrowths, the latter as sinking in of separate cells, muscle cells. The excretory tubes arise from cells of undetermined origin. The flame cells are from the first blind tubes, closed by a protoplasmic mass bearing the numerous cilia.

The author also takes up, in less detail, the embryology of *Melicerta ringens*, a less favorable subject. Here also the precaution was taken to keep the observed embryos up to hatching to avoid the vitiation of results by study of abnormalities.

The cleavage is remarkably similar to that of Callidina. Yet the polar body is found towards the posterior, dorsal end.

Both male and female eggs have the same cleavage and subsequent development in spite of difference of size.

In the author's interpretation of the embryology of Rotifers there is no mesoderm, no middle layer. The sexual organs arise from the entoderm, the cœlon, muscles, pharynx and salivary gland from certain granular ectoderm cells, the circular muscles directly from the adjacent ectoderm and the excretory organs not from the entoderm but probably from the ectoderm. A comparison is thus drawn between the Rotifer and the Trochosphere—the great similarity being overbalanced by the absence of mesoblasts. Thus the Rotifer is to be regarded as an earlier stage than the Trochophore, wanting as yet the special mesoderm mass. The Rotifer is thus not a sexually mature Trochophere. Yet the possession of a subœsophageal ganglia points out a resemblance to the Molluscan trochophore, while there is also much resemblance to an ancestral form for the Polyzoa, Brachiopods and Chætognaths.

The "foot" of the Rotifer is not a ventral organ but to be regarded as a tail or posterior end of the body, having at first a terminal anus afterwards moved dorsally by the formation of a terminal adhesive gland. The embryology of this region is accepted by the author as homologous with that of the abdomen of Crustacea.

While the Rotifers thus stand as representatives of the ancestors of so many groups they themselves are to be divided, as the embryology indicates, from the "Protrochophora" of the Platyhelminthes.

**Development of the Renal Organs of Amphibia.**—In the Bulletin of the Museum of Comparative Zoology at Harvard College,[1] Mr. Herbert H. Field has published a paper on "the development of the pronephros and segmental duct of Amphibia. The early stage were rendered both in the Urodeles (Amblystoma) and Anurans (Rana, Bufo). The paper consists of one hundred and forty pages and is accompanied by eight plates. The descriptive part of the paper includes about the first fifty pages, giving a detailed account of the origin of the pronephros in the three forms.

After an extensive review of the literature the author concludes. "According to the account which at present receives most general acceptance, the pronephros first appears as an outfolding of the somatoplasm in the form of a longitudinal groove; the anterior end of this groove is destined to become the pronephros; the remaining portion is constricted off to form the segmental duct. Since the process of constriction advances from before backwards, stages may be found in which a completed tube is continuous posteriorly with a mere groove of the somatopleure. In the anterior region the groove remains in communication with the body cavity and grows down towards the ventral surface of the embryo in the form of a broad pocket. The slit-like peritoneal opening of this pouch closes throughout the greater part of its length leaving however two or three regions of incomplete closure the fundaments of the nephrotomes."

"In opposition to this view I would maintain; (1) that the first trace of the excretory system consists of a solid proliferation of somatopleure, the pronephric thickening; (2) that the lumen of the system arises secondarily; and (3) that the pronephric tubules do not appear in consequence of the local fusion of the walls of a widely open pouch, but that they are differentiated at an early stage from the hitherto indifferent pronephric thickening."

With respect to the development of the segmental duct the author writes: "As is well known, observers up to a very recent date have been almost unanimous in ascribing a mesodermal origin to this structure. In regards to the details of this process they have been less at one . . . . . According to one view the duct arises as an evagination of somatopleure, its lumen being therefore a detached portion of the body-cavity . . . . My own observations on Amphibia indicate that in this group the duct does not arise as a fold, and I am of the opinion that in both Cyclostomes and Ganoids the evidence that the duct arises as evagination is at present unsatisfactory . . . A second view of the origin of the duct is that it arises from a solid proliferation of somatopleure . . . In so far as these authors maintain that the duct arises from a solid profileration of mesoderm and acquires its lumen secondarily I entirely agree with them; but my own observations on this point lead me to conclude further that the duct arises throughout its entire length from a continous thickening of somatopleure and that the only free growth which occurs in the Amphibia studied by me is for the purpose of effecting a union with the cloaca.

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[1] Vol. xxi., No. 5, June, 1891.

"Finally it remains for me to consider the third view, that of the ectodermal origin of the duct, which is to-day advocated on so many sides . . . In my opinion the entire excretory system of the forms I have studied unquestionably develops without any participation of the ectoderm in its formation. The duct develops from mesoderm throughout its entire length and at its posterior end, in Rana and Bufo at least, comes in contact with one of the endodermal coruna of the midgut so that nowhere in its development does it come into organic union with the outer germ layer."

An intimate fusion in several processes between the duct and the ectoderm has been described but this fusion the author concludes is secondary and meaningless (?)

The remaining part of the paper deals with "those inferences of a general nature" drawn from a study of the pronephros.

"I conclude therefore that pronephros and mesonephros are parts of one ancestral organ; that the glomeruli are strictly homodynamous with the glomus; that the entire tubular portion of the pronephros is represented in the mesonephros; that the cavity of a Malphigan capsule and the nephrostomal canal connecting it with the body cavity are detached portions of the cœlom, the equivalents of which are not thus differentiated in the pronephros; that the pronephros is developed as a larval excretory organ; and that the period at which it appears largely accounts for its peculiarities of structure."

The closing sections are devoted to a consideration of the evidence which the development of the excretory system throws on the origin of the vertebrates. On the whole, the evidence brought forward does not add materially to the solution of the ancestry of the vertebrates and such a theory can only be established by investigations which shall include in their scope the entire organization of the two groups.